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## ARTICLE II.

### NOTES ON THE GEOLOGY OF WEST VIRGINIA.

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Read before the American Philosophical Society, Feb. 16, 1872.

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IN this paper I propose to describe the carboniferous series as displayed in a portion of Monongalia and Marion counties, West Virginia, the extension of that part of Pennsylvania described in the reports as the Third Great Basin south of the Ohio, first subdivision.

Laurel Hill, the eastern boundary, appears to attain its greatest importance in the neighborhood of Uniontown, Pa., from which point it gradually diminishes southward, until at the Valley Falls of the Monongahela River, about thirty miles south from the State line, it becomes so insignificant that the Mahoning sandstone passes over it, unbroken. The western boundary is the first sub-axis of the third great basin of Pennsylvania, and was termed Brush Ridge in the report. It is almost parallel with Laurel Hill in Pennsylvania, but near the line it turns towards the southwest, and very soon ceases to affect the dip. The breadth of the sub-basin in its northern part varies little from eight miles. I have chosen to regard this as the average width of the section to be examined, although the western boundary soon disappears and the sub-basin as such no longer exists.

Through the whole district the Monongahela river runs with a course irregularly north and south, cutting through Laurel Hill near Valley Falls. Its numerous tributaries from the east afford excellent natural sections of the lower groups, while those from the west afford equally satisfactory illustrations of the upper coals. Cheat River runs through the northeastern corner. The village of Morgantown is on the bank of the Monongahela, about six miles south from the State line; and Fairmount, on the same river, is twenty miles south from Morgantown. I shall make no reference to the portion lying north from Cheat river, as that has been fully discussed by Prof. W. B. Rogers, in his report on property connected with the Pridevale Iron Works.

The superficial deposits here are very thin. Along the Monongahela, terraces of limited extent are occasionally seen, but along the smaller streams they are not readily distinguishable.

The rock deposits belong to the carboniferous age exclusively. In the gaps made by the Cheat river and Decker's creek near Morgantown, we find the sandstone, limestone and shales of the Lower Carboniferous, Umbral of Rogers. On these rests the great conglomerate, which forms the saddle of the mountain, and which may be seen beautifully curving in the gap of Decker's creek. On the flank of Laurel Hill the coal measures begin, from which line they continue without serious interruption to the western limit of the coalfield in Ohio. The district under consideration shows a small anticlinal axis, parallel to Laurel Hill, which crosses the Monongahela just at Morgantown, and has a marked effect on the dip, reducing it from nearly two hundred feet per mile, near the mountain, to little more than thirty feet per mile west of the axis. As already stated, Brush Ridge, or the first sub-axis of the third basin of Rogers, has little effect on the dip.

#### THE COAL MEASURES.

In describing the coal measures, I have thought it best to adopt the terms used in the Geology of Pennsylvania and the Virginia Reports, for, though they may not have been based on scientific grounds, they are most convenient for description, as the rocks are here developed.

The Lower Coal Group extending from the conglomerate to the Mahoning sandstone is found on the sides of the mountain, and disappears not far from its foot. It contains one, or in some localities two workable seams of coal and some valuable deposits of iron ore. The Lower Barren Group rests on the Mahoning sandstone and reaches to the base of the Pittsburgh coal. It contains a seam of coal, sometimes workable, several deposits of ore, and some limestone. The Upper Coal Group begins with the Pittsburgh coal, and includes the Waynesburg coal, with its overlying sandstone. It contains four beds of coal, all of large size, and an immense deposit of limestone. Its eastern limit is within two miles of Laurel Hill, and it disappears from four to five miles west from the mountain. The Upper Barren Group includes all above the Waynesburg Sandstone, if I may so term it. Only a small portion is seen in this district, and that only near the western limit. It is developed chiefly in the second subdivision. It contains four beds of coal, two of workable thickness, but all of rather poor quality.

#### UPPER BARREN GROUP.

This is composed chiefly of shales and sandstones. No satisfactory sections have been obtained, as the hills are usually rounded by erosion and covered with soil. On

the Aiken tract, near Dankard creek, thirty-five miles northwest from Morgantown, the blossoms of several small beds are seen; but of these only one has been examined. This is eighteen or twenty inches thick. About fifteen miles east of this, at Price's, is a four feet seam of moderately good quality, from which coal is obtained for smiths' use. Above this, perhaps fifty feet, is another seam of nearly the same thickness, which is opened at Brown's Mills. It is slaty and of very poor quality. Five or six miles east of Price's, there is said to be a five feet coal worked near the hill-top. Of this I know nothing, not having seen it. On Scott's Run, a small seam, one foot thick, and perhaps eighty feet above the Waynesburg, was struck by Mr. Lumley in boring a well at the head of Ramp's Hollow. Exposures are so rare that it is impossible to determine the dip with any degree of accuracy. Otherwise the distance between these coals might be calculated. The intervals, as already stated, are filled with shales and sandstones, limestones being almost wholly absent until the Aiken tract is reached.

#### UPPER COAL GROUP.—MONONGAHELA RIVER SERIES.

The approximate section of this group is as follows:

1.	Sandstone, "Waynesburg,"	30—40 feet.	
2.	Shale,	1—15 "	
3.	Coal, "Waynesburg,"	6—9 "	
4.	Sandstone,	15 "	Interval rocks 183 to 207 feet.
5.	Shale,	8 "	
6.	Limestone,	5 "	
7.	Shales and sandstone,	20 "	
8.	Limestone and shale,	30 "	
9.	Sandstone and shale,	35 "	
10.	Limestone,	6 "	
11.	Sandstone,	15 "	
12.	Limestone,	7 "	
13.	Sandstone,	10 "	Interval rocks 40 to 49 feet.
14.	Limestone,	8 "	
15.	Sandstone and shales,	23 "	
16.	Shale,	1—25 "	
17.	Coal, "Sewickly,"	4½—6 "	
18.	Shale,	5—8 "	
19.	Limestone,	9 "	
20.	Sandstone,	4—10 "	
21.	Limestone,	22 "	Interval rocks 18 to 60 feet.
22.	Coal, "Redstone,"	4—5 "	
23.	Fireclay,	1 "	
24.	Limestone,	12 "	
25.	Shale,	5—12 "	
26.	Sandstone,	0—35 "	
27.	Coal "Pittsburgh,"	7—14 "	
28.	Fireclay,	3 "	

*Waynesburg Coal.* The eastern outcrop of this bed is about four or five miles northwest from Laurel Hill. There it caps the highest hills and dips gently to the northwest. This dip is retained until the coal approaches the axis or western limit of our sub-basin, where it is slightly reversed. The bed is everywhere double, which, as well as the heavy overlying sandstone, has led some local geologists to identify

it with the "Pittsburgh," which, they believe, runs out in the hills south from Brownville, and does not re-appear to the south again until it reaches the neighborhood under consideration.

On Scott's Run, the first openings are seen high up in the hills about two and one half miles from the river, where the coal is worked by Core, Aiken and Ira Ramsay. Mr. Aiken's bank furnishes the following section; sandstone, very coarse, 30 feet; shale, 1 ft. 2 in.; *coal*, 1 ft. 9 in.; bituminous shale, 1 in.; *coal*, 4 ft. 10 in. At Cassville, one mile and one half higher up the run, the intervening shale disappears and the whole bed increases in thickness, so that, at Tucker's bank, it shows full nine feet of coal. Numerous openings in this neighborhood show no material difference, and the seam is generally known as the "eleven foot vein."

On Robinson's Run this coal is worked near Bowlesby's Mills, where it shows the following section:—Shales with some iron, not measured; Shale, very bituminous, and with thin laminae of *coal*, 2 feet; *Coal*, 1 ft. 6 in.; Clay 7 in.; *Coal*, 4 ft. 8 in. At this point, five miles from the river, the bed approaches closely to the axis and dips very slightly south-east. No other openings were seen. The coal is locally known as the "Cassville Coal."

The development of this bed here is remarkable, and appears to be limited to our sub-basin. At no point observed does it show less than six and one-half feet of coal, and at Cassville it reaches nine feet. I have not been able to find it in the adjoining county of Marion, and so cannot tell how it may hold out to the south. To the north-west it shows a diminution in size, giving the following section at Waynesburg, Penn.: *Coal*, 1 ft. 8 in.; Clay, 1 ft. 2 in.; *Coal*, 3 ft. 2 in. At Wheeling, W. Va., the thickness is only two feet six inches, and it is single.

In the coal, as seen on Scott's and Robinson's Runs, the laminae are coarse and irregularly prominent, often one-third of an inch thick, giving a ligneous appearance. Laminae of mineral charcoal are found at irregular distances and of varying thickness, but preserving the vegetable structure, and looking much like crushed cane. In some of these fragments of a *Cordaites* can be recognized. When rudely broken, it frequently resembles an impure cannel. It burns with great readiness, and for the most part has no considerable tendency to cake upon the fire. As seen on Scott's Run, the lower bed is a good coal, very compact, and in high repute. The upper bed shows numerous thin seams of pyrites, and at times is very slaty. At some points it is a very bad coal. On Robinson's Run, the lower bench, if one may judge from the outcrop, contains a good deal of pyrites, not readily distinguishable, however, in the sound coal, within the opening. The upper bed tends to run into bituminous shale, and is not of very good quality.

*Sewickly Coal.* In the neighborhood of its eastern outcrop, near Stewartstown, this coal seems to have suffered so much from aboriginal erosion, during the deposition of the overlying stratum, as to have lost all economical value, rarely exceeding one foot in thickness. At that point, one of the highest in the county, it is well exposed; but it does not show itself again, as far as observed, east of the Monongahela River. West of the river, we find it nearly six feet thick, on Mr. Boyer's property, at the mouth of Scott's Run. At Mr. Newkirk's, one mile up the run, it is four feet six inches. At Ira Ramsay's, one mile further, it is five feet, and a short distance beyond, where it sinks under the run, is five feet eight inches. It has been opened at many points along Scott's Run, and, at all these openings, it is divided near the middle by a layer of cannel coal varying from two to six inches in thickness. The lower portion is compact, and contains but little pyrites, while the upper part is softer, and apparently altogether free from pyrites.

On Robinson's Run only one opening was observed—about three miles from the river, a short distance above the school-house. There the bed is four feet six inches thick, and has a thin clay parting near the middle. The cannel coal is about one foot from the bottom, and is not so well marked as in the Scott's Run openings. The coal is very free from pyrites, but is rather friable. At this opening the dip is southerly.

At Laurel Point, on the road to Fairmount, the coal is six feet thick, and the cannel does not appear.

In this coal the laminae of mineral charcoal, though thin, are at short distances apart. Along the planes of vertical cleavage it shows a neat, clean surface, brightly polished, and none of the ligneous structure belonging to the Waynesburg bed. The fracture is irregular. The coal is remarkably pure. Fifty bushels, which had lain on the dump for a year, exposed to sun and rain, were still brilliant and compact, showing no disposition to slack. On the fire it is almost open-burning, having a very slight tendency to cake. The upper or softer portion on Scott's Run, is in great favor among blacksmiths, owing to its purity, while coal from any part of the bed is highly regarded for domestic purposes. It is undeniably a coal of singular excellence in every respect.

*Redstone Coal.* This coal is seen at many points along the road leading from the Ice's Ferry pike to Stewartstown. At the latter place it is well exposed on many farms, and shows a thickness of about four feet at its outcrop. The Pittsburgh coal, below, is so accessible there, and is so much thicker, that no openings have been made in the Redstone bed, so far as I could ascertain. The coal along the road, referred to, lies very near the hill-tops, so that the area is quite circumscribed and the quality rather poor.

West of the river it is seen near the mouth of Scott's Run, on Mr. Boyer's property. It is there about four and one-half feet thick, and was worked somewhat, many years ago, for blacksmiths' use, the coal being very pure. A mile and a half up the run, a little stream comes in, on which this bed is exposed, showing a thickness of four feet. The next exposure is by the side of the road at the "fill." The coal disappears under the run at Stumptown, opposite Ira Ramsay's house, a little more than two miles from the river. There is now no opening on Scott's Run, and it is almost impossible to speak positively respecting its character there.

On Robinson's Run, a short distance above Mr. Murphy's house, perhaps two and one-half miles from the river, several rude openings have been made. Here the coal is four feet nine inches thickness, showing a clear bright wall at the end of the drift. The coal is very brilliant and compact, coming out in large blocks, two feet from the outcrop, and showing little disposition to disintegrate upon exposure. At these openings the fireclay varies in thickness at the expense of the coal, sometimes cutting out a foot. The bed disappears a short distance beyond this locality.

Wherever seen, this is the clearest and purest coal in the basin. It seems to contain a very inconsiderable proportion of pyrites, and it has always been in great favor among the blacksmiths. Openings in this as well as the Sewickly are not numerous except in short distances. The people evidently regard a four or five feet seam too thin to pay, and the inclination is to depend on the Pittsburgh coal. Along Scott's Run there are, however, some who appreciate the excellence of these coals, and use them in preference to those of the Pittsburgh bed, even abandoning openings into the latter bed on their own property.

The Sewickly and Redstone coals diminish in thickness toward the south and west. At Fairmount, twenty miles south from Morgantown, the Redstone is three to three and one-half feet thick, with a slaty parting. The Sewickly reaches four feet and has a parting of bituminous shale. They appear to be represented at Wheeling by two seams, twenty feet apart, and each five inches thick.

*Pittsburgh Limestone.* Under this term I include all the limestone below the Waynesburg coal, although I am aware, that it does not rightly cover so much. The total thickness is about one hundred feet in three hundred and fifty feet of strata. The color varies from light blue to almost black, while most of the strata are quite compact. The layers in each stratum are separated by thin calcareous shale. No 12 of our section yields a good hydraulic lime, which, however, has sufficient tendency to slack to prevent its being a cement of high grade. No fossils have been found in any part of the deposit here; but at Wheeling, a layer of bituminous shale, about two inches thick, occurs thirty-five feet above the coal, and contains a great number of

minute fossils. These are very indistinct. The bivalves resemble *Cardiomorpha*, and the univalves, *Spirorbis*. Mr. Meek has informed me that he found a little shell, resembling *Pupa*, in that locality.

*Pittsburgh Sandstone.* This rock accompanies the Pittsburgh coal at its easterly outcrop along the line of strike from the Pennsylvania line to Pruntytown, thirty miles south from Morgantown, and doubtless further, but my observations terminated there. At a distance of about three miles from the eastern outcrop, it has entirely disappeared. To determine the line upon which it disappears is impossible, as the coal itself has been removed by denudation to a distance of more than a mile, east of the Monongahela, and to almost as great a distance west of the river opposite Morgantown. After crossing the river below Morgantown, one finds no vestige of the rock, nor does it re-appear at any point west on the Ohio side of the great basin.

This sandstone is usually coarse-grained, with feldspathic sand, and some pebbles of quartz, often numerous enough to render it conglomerate, a character which it shares with the sandstone overlying the Waynesburg coal. Its stratification is very irregular, and the material is so uneven in compactness that, in weathering, its surface becomes honeycombed. The thickness varies little from thirty-five feet.

*Pittsburgh Coal.* Along its eastern outcrop, as already stated, this coal is overlaid by the Pittsburgh sandstone, and where so accompanied the lower bench only is present. The upper bench was doubtless removed by denudation during the deposition of the overlying sandstone. A local geologist, residing not long since at Morgantown, erroneously identified this coal with the Upper Freeport, alleging that it disappears under the Monongahela, about fifteen or twenty miles south from Brownsville, and does not rise again until it passes some distance north from Pittsburgh, where it is supposed to lie one hundred and fifty feet under the river. This locally prevalent mistake has doubtless arisen from the confusion produced by the frequent and extensive curves in the Monongahela river.

The most easterly outcrop is on the property of Mr. House, near the Ice's Ferry Pike, about a mile west from Cheat River. Not far from this point, it is worked by Mr. Anderson, and is eight feet thick. At Anderson's Store, four miles east from Morgantown, it is worked by M. Koontz, and is about the same thickness. Turning north at Anderson's Store and following the road to Stewartstown, the first opening is Smith's bank. Here a black shale lies between the sandstone and coal. The coal is *eight feet two inches* thick, with numerous thin partings of highly bituminous clay, quite distinct near the outcrop, but not readily traceable in the solid coal. Some thin seams and occasional nodules of pyrites are seen, but the quantity does not appear to



be sufficient to injure the coal. Two other openings in the vicinity show the same characteristics.

In the neighborhood of Stewartstown, seven miles from Morgantown, this coal is finely exposed in ravines upon the farms of Major Johns and Henry Coombs, two hundred and fifty feet below the village church. Several openings have been made, in all of which the bed shows a thickness averaging about *eight* feet. It is quite hard, usually somewhat dull in color, showing little pyrites, but evidently containing some sulphur, as appears from analyses of coal from this locality recently made by Dr. Newberry. About a mile north from Stewartstown, on a farm belonging to the Misses Lewellyn, this coal is said to be eleven feet thick.

Returning to the Ice's Ferry Pike we find, one mile from Morgantown, a number of openings to supply the village. In these the coal varies from six to eight feet in thickness. At two of the openings, the sandstone rests directly on the coal, forming a very irregular surface. To the northwest from these, perhaps, half a mile or a mile, are several other openings. In the former the coal is very black, of dull lustre, and of very variable quality. In the latter it is chiefly irised, quite soft, and contains much less pyrites than the others.

Two miles south from Morgantown, on the west side of the river, Capt. Sears has opened this coal and finds it about nine feet thick and of excellent quality. No further exposure known to me occurs to the south until reaching Smithstown, twelve miles from Morgantown, where it is found in the hills between the village and the river. From that point it is readily traceable to where it crosses the Kanawha river. I have observed the sandstone as far south as the Falls of the Valley river. All along the line the upper layers are wanting, and the average thickness of the bed varies little from nine feet.

Descending the Monongahela from Morgantown, we first find the coal back of Granville, west of the river, where it is worked by Dr. Dent. Two miles below, near the mouth of Scott's run, Boyer's old opening gives the following section: Bituminous shale 1 ft.; coal 3 in.; shale 1 ft. 8 in.; coal 1 ft.; bituminous shale 1 ft.; coal 9 ft. 6 in. About a mile further up the run, near Haigh's Mill, the seam is thicker and shows as follows: Shale 5 ft.; coal 3 in.; shale 1 ft. 9 in.; coal 1 ft. 3 in.; shale 1 ft. 5 in.; coal 10 ft. The coal here is of good quality, with some iron pyrites, and is rather soft. The shale above the main coal contains numerous vegetable remains, but they are for the most part indistinct. A *neuropteris* and a *cordaites* are the only ones that can be determined. The upper coal is said to be remarkably pure. The seam disappears under the run, about two miles from the river. North from Scott's run, the bed shows some interesting variations. On a little stream one mile below, we find: Lime-

stone 14 ft.; shale 3 ft. 8 in.; *coal* 4½ in.; shale 1 ft. 10 in.; *coal* 1 ft.; shale 10 in.; *coal* 8 ft. 3 in. Not far from this on Courtney's run, a tributary of Robinson's run, we find the following section on Mr. Davis' property: Shale; *coal*, slaty, 1 ft. 9 in.; shale 3 ft. 5 in.; *coal* 4½ in.; shale 1 ft. 10 in.; *coal* 1 ft. 4 in.; shale 10 in.; *coal* 8 ft. 8 in. On Robinson's run, nearly three miles from the river there are several deserted openings which give a section very nearly like the last: Limestone 14 ft.; shale, dark, 2 ft.; *coal*, slaty, 2 ft.; black shale 3 ft. 6 in.; shale very bituminous, 10 in.; *coal* 1 ft. 3 in.; shale, very bituminous, 1 ft.; *coal* 8 ft., exposed.

The variations of this bed are better marked in this district than in any other known to me. Along the eastern outcrop it has but one layer of coal and one of shale, the latter being occasionally absent. On Scott's run we find two additional layers of coal, with intervening shale; on Courtney's run a third layer is added, with shale; while on Robinson's run the two upper layers of Scott's run are together, the thin 4 in. lying directly upon the lower one, but distinct from it, the two amounting to 1 ft. 3 in., as above given.

The quality of the coal from this seam varies so much at different banks that no positive general statement respecting it can be made with safety. The coal is usually soft, very bituminous, and cakes readily upon the fire. Where not too pyritous, it is an excellent gas coal, for which purpose it is extensively mined at Fairmont. From that point Pierpoint & Watson have shipped to the east about 40,000 tons per annum. Were proper means of transportation afforded, this firm could do three times as much; but the Baltimore & Ohio R. R. Co. evidently seeks to discourage coal mining west of Cumberland, as it neglects or refuses to provide enough cars to accommodate the business. The coal shipped from Fairmont rates hardly so high in the eastern markets as that from Connellsville in Pennsylvania.

North from Fairmont to the Pennsylvania line the coal has been worked only for domestic use. No railroad opens up the country, and the Monongahela as a navigable stream is too uncertain an outlet. One is surprised to learn that this whole section is an unknown land to capitalists, that coal adds no value to property, and that farms with twenty-seven feet of coal, have been offered for sale at twenty dollars per acre, within a year, without finding a purchaser. Under such circumstances there has been no inducement to experiment. There can be no doubt, however, that at two or three banks, near Morgantown, as well as at other localities, the Pittsburgh seam yields a very superior coal for gas and coke. This will soon be of considerable value, as two railroads connecting with the Pennsylvania Central are in course of construction toward Morgantown, and preliminary surveys have been made by U. S. engineers, with a view to the immediate slackening of the Monongahela.

## LOWER BARREN GROUP. [BARREN MEASURES.]

An approximate section of this group is as follows :

1. Shale with iron,	14 feet.	}	Interval rocks 16--18 feet.
2. Limestone,	2—4 "		
3. <i>Coal</i> ,	1½—2 "	}	Interval rocks 86½ feet.
4. Shale,	3 feet.		
5. Sandstone,	25 "		
6. Shales,	8 "		
7. Limestone,	3 "		
8. Shale with iron,	4½ "	}	Interval rocks 10—25 feet.
9. Limestone,	1½ "		
10. Shales and shaly sandstone,	22 "		
11. Limestone,	1½ "		
12. Shale,	18 "		
13. <i>Coal</i> ,	1½—2 "	}	Interval rocks 88—94 feet.
14. Sandstone,	10—25 "		
15. <i>Coal</i> ,	8 in.—1½ "		
16. Limestone,	8 "		
17. Shales olive,	10 "		
18. Limestone,	3 "	}	Interval rocks 45—60 feet.
19. Shale olive,	12 "		
20. Sandstone,	40 "		
21. Conglomerate,	0—6 "		
22. Sandstone,	15 "		
23. <i>Coal</i> ,	3½—4 "	}	Interval rocks 60½ to 65½ feet.
24. Shales variegated with some shaly sandstone,	33½ "		
25. Sandstone,	1—4 "		
26. Shale, calcareous and fossiliferous.	2—4 "		
27. Shale, variegated, fossiliferous,	24 "		
28. <i>Coal</i> ,	4 in.—1½ "	}	Interval rocks 45—60 feet.
29. Limestone,	5 "		
30. Shales, variegated with iron,	20 "		
31. Sandstone,	10—20 "		
32. Shales with iron,	10—15 "		

*Coals.* The coals of this group are, for the most part, of little interest, and none appear to be of economical importance. No 3 is seen on Robinson's and Scott's runs, reaching occasionally a thickness of two feet, and yielding a coal of excellent quality. It has been worked in one or two instances where the owner was ignorant of the proximity of the Pittsburgh coal. Nos. 13 and 15 are never of available thickness; though I have been informed that, at one point below the mouth of Scott's run, along the river, No 13 expands to twenty inches. No 15 is about as bad a coal as one often sees, its outcrop, where protected by projecting rock, being coated with crystals of copperas.

No 28, which may be the equivalent of the Elk Lick coal, is exceedingly variable in size and appearance. At the "Hog Back" on Decker's creek, one mile from Morgantown, it varies from *four* to *twelve inches* in thickness within one hundred feet. It breaks into small blocks, an inch or two each way, and bears much resemblance to an imperfectly formed cannel. At some points it is slaty, at others entirely free from any such structure. Many years ago it was opened two miles south from Morgantown, near the poor-house. There it is nearly *twenty inches* thick and of very poor quality—a richly bituminous shale, of the kind usually termed "cannel coal," by courtesy.

No. 23 in its local development is of some importance. I have seen it only east of the Monongahela, but it exists on the west side. Thirty years ago it was opened near Decker's creek, three miles from Morgantown. At the same time it was opened in the hill opposite the University, near the village. Two or three years ago it was opened in a ravine east from the village, with a view to supply the village. The work was abandoned owing to the thinness of the bed, which made the cost of extraction too great to admit of competition with the openings into the Pittsburgh. During the present year it has been opened by Mr. Millar, opposite the University, and also by Mr. Fordyce, a short distance to the north, merely to supply the owners.

At Mr. Millar's opening, the seam shows: Bituminous shale six to eight inches; *coal* three to three and one-half feet. The general structure of the coal is slaty, and in some portions its fracture resembles that of impure cannel. In others it is distinctly conchoidal and of the color of lignite; while again it resembles the Grahamite of Ritchie County, or the Albertite of New Brunswick, to a wonderful degree. Near the bottom, the coal is very hard and brilliant, apparently only semi-bituminous. It does not ignite as readily as the other coals of this region, but lasts longer on the fire, and produces an intense heat. In burning, it gives off little soot, not enough to coat the pipe, "being almost as clean as wood," as Mr. Millar expressed it. It, however, contains a considerable amount of free sulphur, which renders it very hard upon stoves. The ashes are bulky but light, and contain no cinders, as the coal burns up clean. It is unfortunate that this coal has so much sulphur, as otherwise its very large proportion of fixed carbon would render it very valuable for manufacturing purposes here where the available coals contain so much volatile matter. This bed is frequently cut up by "horsebacks" and "mudseams."

*Iron.* In the shale No. 1. there is usually found a highly valuable deposit of protocarbonate of iron, rich and pure, locally known as the "Olyphant blue lump." Near Uniontown, Pennsylvania, it is well developed, and Mr. Olyphant has worked it successfully there for many years, in Fairchance furnace. On Scott's run, near Haigh's mill, the quantity is considerable, and one may work out half a ton of nodules in a short time with but little labor. According to the Pennsylvania surveyors this deposit is not found to the north from Redstone Creek; and I have been informed by Hon. F. H. Pierpoint, who is engaged in mining the Pittsburgh coal at Fairmont, that it does not appear under the coal bed there. It is said to be found south from Fairmont, near the Monongahela river. The distribution of this ore is of much economical importance, as it is the most extensive deposit in this region. In No. 10, nodules of large size are common; but the character of the rock is such as to render profitable mining impossible. No. 30 contains two seams of ore. The lower is irregular in

thickness, averaging about six inches, of moderately good quality, and occasionally calcareous. The upper is nodular, but seldom of sufficient thickness to prove of value. Both seams sometimes disappear altogether. The seam of ore in No. 32 is near the bottom of the stratum—an irregular band of nodules, of low grade. Many years ago it was extensively taken out to supply the old furnace on Decker's creek, where, in combination with other and better ores, it was successfully worked. No. 24 contains an irregular band about a foot thick which has never been tested.

The *Conglomerate*, No. 21, is a curious stratum varying in thickness from a few inches to several feet. It is made up of fragments of limestone, sandstone, and iron ore, in size from fine sand to that of a man's head. These fragments are usually rounded, as if by currents existing before or during the time of deposition. Thin layers of homogeneous sandstone or shale may be traced to a considerable distance; and at one point there is a layer of iron ore one foot thick. The extent of this stratum is not known, and I doubt whether it exists west of the river.

The *Sandstone*, No. 20, appears to be equivalent to the one described at Pittsburgh in the Pennsylvania Report. The lower portion is usually compact, affording a handsome and durable building stone. The lines of deposition are often well marked, and not unfrequently the iron there deposited gives the rock a yellowish tint. The upper portion presents a curiously shattered appearance where exposed, due evidently to the decomposition of nodules of impure iron ore.

*Shales, Fossiliferous*, Nos. 26 and 27, form an interesting little group with the following section: Shale, calcareous, blue, gray or black, 3 ft.; dark shale, with many small ferruginous nodules 12 ft.; calcareous nodules 1 ft.; olive shale 4 ft.; brown shale 6 ft. Excepting the brown shale at the bottom, which does not appear to be persistent, all the layers are richly fossiliferous. The following species have been obtained from this series: *Hemipronites crassus*, *Chonetes Smithii*, *C. granulifera*, *Productus Nebrascensis*, *P. Prattenanus*, *P. semi-reticulatus*, *Orthis carbonaria*, *Athyris subtilita*, *Spirifer planoconvexus*, *S. cameratus*, *Lima retifera*, *Aviculopecten carbonarius*, *A. occidentalis*, *Nucula parva*, *N. ventricosa*, *N. (?) anodontoides*, *Nuculana bellistriata*, *Yoldia carbonaria*, *Y. Stevensoni*, *Edmondia Aspenwalensis*, *Astartella concentrica*, *Macrodon obsoletus*, *Solenomya radiata*, *Macrocheilus primigenius*, *M. ventricosus*, *Euomphalus rugosus*, *Bellerophon Montfortianus*, *B. percarinatus*, *B. carbonarius*, *B. Stevensanus*, *B. Meekianus*, *Pleurotomaria Grayvillensis*, *Orthoceras cribrosum*, *Nautilus occidentalis*, *Petalodus Alleghaniensis*, and undetermined species of *Myalina*, *Pleurophorus*, *Edmondia*, *Deltodus*, *Lophodus* and *Ctenoptychius*. Fish teeth are very rare; a few crinoidal stems and bryozoans have been found near the top. This series is well exposed at several points on Decker's creek, but the fossils are not usually in

very good condition. At another exposure, in a ravine on Mr. Williams' property, five miles north from Morgantown, specimens of nearly all the species named above can be obtained, in excellent preservation. It is a little curious that not a single specimen of *Chonetes mesoloba* occurs in any stratum here, its place being taken by a small variety of *C. granulifera*. The *Productus semi-reticulatus* of this region is very closely allied to *P. costatus*, and I am inclined to regard it as identical with the American variety of the latter species. For the most part the specimens of the species above given are much smaller than similar specimens from the west, and some are almost dwarfed. Mr. F. B. Meek described four new species of shells from this series in Report of the Regents of W. Virginia University for 1870.

LOWER GROUP. [ALLEGHANY RIVER SERIES.]

The section is as follows :

1. Sandstone, "Mahoning,"	75 feet.	} Interval rocks 87 feet.
2. Shale,	12 "	
3. Coal,	1½ "	
4. Shales,	1-25 "	} Interval rocks 1-25 feet,
5. Coal,	4-5 "	
6. Shale,	10 "	} Interval rocks 10 feet.
7. Coal,	1 "	
8. Sandstone,	5 "	} Interval rocks 50 feet.
9. Shale,	10 "	
10. Limestone. "Ferroferous,"	4-5 "	
11. Shale,	30 "	
12. Coal,	3½ " (?)	} Interval rocks 20-30 feet.
13. Sandstone and Shale,	20-30 "	
14. Coal,	2-3 "	
15. Shale,	15-20 "	} Interval rocks 65-75 feet.
16. Sandstone, "Tionesta,"	25-30 "	
17. Shale,	25 "	
18. Coal,	1¾ "	} Interval rocks 4 feet.
19. Sandstone,	4 "	
20. Coal,	1 "	
21. Shale.	10 "	

*Mahoning Sandstone.* For the most part this is a massive rock, with alternating coarse and fine layers. The former are sometimes conglomerate, and the soft layers above them are pitted on the other side, so as to appear covered with rain markings. In some portions it is flaggy, while in others it is compact and very suitable for building purposes, as blocks six to eight feet thick can be quarried without difficulty. Rude vegetable impressions are not unfrequent, but are invariably too indistinct for identification. This stratum comes down to the level of Decker's creek about four miles from Morgantown. The dip at that point is so diminished as to be almost imperceptible, but is soon reversed and becomes slightly southeast. At the mouth of Decker's creek about forty feet are visible. Here it regains its north-westerly dip and disappears under the river near Granville, two miles below Morgantown. To the south it rises quite rapidly, and at Booth's creek, four miles south

from Morgantown, it is nearly forty feet above the river. There it shows a bluff of about seventy-five feet, weathered into large rounded cavities, in some portions, and in others showing a strangely honeycombed surface.

*Iron Ore (Fossiliferous).* On Decker's creek there rests under the sandstone a dark shale, twelve feet thick, and containing near the middle a band of nodular iron, about two feet thick. It contains an interesting assemblage of fossils, of which the following are the most numerous: *Lophophyllum proliferum*, *Zeacrinus mucrospinus*, *Ersocrinus*, *Cyathocrinus*, (?) *Hemipronitus crassus*, *Productus Nebracensis*, *Productus Prattenanus*, *Athyris subtilita*, *Aviculopecten carbonarius*, *Aviculopecten Hertzeri*, *Nucula ventricosa*, *Nuculana arata*, *Yoldia carbonaria*, *Astartella concentrica*, *Macrocheilus primigenius*, *M. Ventricosus*, *Polyphemopsis peracutus*, *Euomphalus rugosus*, *Bellerophon Montfortianus*, *B. carbonarius*, *B. percarinatus*, *Pleurotemaria Greyvillensis*, *P. speciosa*, *P. carbonaria*, *P. (?) tumida*, *Orthoceras cribrosum*, *Philipsia Sangamonensis*, together with numerous undetermined species of *Myalina*, *Schizodus*, *Allorisma*, *Pleurotomaria*, *Nautilus* and *Deltodus*. On Booth's and Coburn's creeks this shale is not present, or, if present, is represented only by a black band four inches thick, which rests on a thinly laminated shale twenty feet thick, containing numerous fragments of *Nevropteris*, *Sphenopteris*, *Annularia* and *Sphenophyllum*. It seems to be present on White Day Creek, twelve miles south from Morgantown. It is not persistent in Ohio or Pennsylvania.

*Coal No. 3 of Section.* On Decker's creek, a small seam of coal, fifteen inches thick, underlies this shale. Some years ago it was worked near the Point House, on that stream. The coal is said to have been of excellent quality. This seam does not appear on Booth's creek, nor do I know of its existence on White Day. A coal bed occupying the same position has been slightly worked at Nuzum's Mills, seven miles south from Fairmont, on the Baltimore & Ohio Railroad. It is nearly three feet thick.

*Coal No. 5 of Section* is the important and persistent seam of this group. It appears on Cheat river, near Ice's Ferry, and is there worked on the north side of the river. It has been worked on Tibb's run, a tributary of Decker's creek, on the creek, and in some of the ravines opening upon it. In these localities it is four feet thick, divided near the bottom by a thin clay parting. The shale above for several feet is very bituminous, with a conchoidal fracture, and is sometimes irised. It is undoubtedly a cannel coal of inferior quality, and in some places has been worked with the coal below. The coal is very friable and breaks into rhombic pieces. Traced southwesterly this bed crosses Aaron's creek near the Kingwood road, about four miles from Morgantown, and is worked by Mr. Bell. It also appears at several points along Coburn's creek.

On the Evansville road, about seven miles from Morgantown, it is opened by Mr. William Howell. Here it lies directly under the Mahoning sandstone, and gives the following section: *Coal* 3 ft. 1 in.; clay shale 2—4 in.; *coal* 1 ft. 3 in.; shale 2 in.; *coal* 3 in. Evidently the whole bed is not worked here, for on the other side of the hill there appears to be a foot or more of coal above. It is not well exposed, but I was informed that it did not pay to work more than the lower four feet.

*Coal* (local). Ten to fifteen feet below this coal, on a tributary of Decker's creek, there is a small seam about one foot thick. It appears to be exceedingly local, as it has not been found on Decker's creek, or to the south.

*The Ferriferous Limestone* (No. 10) is frequently double, with intervening shale sometimes several feet thick. Toward the top it contains cavities with ochre, is very ferruginous, and at one or two localities it has been worked as a calcareous ore. It is quite persistent for twenty miles south of the Pennsylvania line, but does not appear in the section at Nuzum's mill. The rock was used as a flux at the old furnace on Decker's creek and at Clinton Furnace on Booth's creek. It affords a good strong lime, well fitted for agricultural purposes and for rough work. Little use has been made of it. One cannot fail to wonder at the lack of enterprise among farmers here, when he learns that, in a country where limestone shows itself in almost every hill, lime commands fifteen cents per bushel at the kiln.

*Coal*, No. 12, (of the main section) I have not seen. It was worked many years ago on Decker's creek, a little below the old furnace, but the openings and exposures have been so concealed by heavy slides that direct information can be obtained only with great difficulty. It is said by old miners to be from three and one-half to four feet thick, and to resemble cannel. The shales above it are laminated and highly bituminous. They burn readily and have been mistaken for cannel coal.

*Coal*, No. 14, was identified with the Brookville, by Prof. H. D. Rogers. It has been opened at several points along Decker's creek and its tributaries, and is in high repute for domestic use. It is friable, free from pyrites and has been termed locally, the "Blacksmith's Vein." At an opening near the furnace the coal is beautifully irised. It was formerly worked near Clinton Furnace; but, after the discovery of the larger seam above, the workings were abandoned. The openings are now filled up and no satisfactory information can be obtained. So far as known to me it has not been worked at Nuzum's mill.

*The Tionesta Sandstone* (No. 16), varies in texture from moderately coarse conglomerate to fine-grained sandstone. Compact and flaggy layers alternate on Decker's creek. On Booth's creek, it is mostly compact. At Nuzum's mill the texture is uneven, and it has weathered so as to leave huge chambers. The compact layers



are very refractory, and some of them have been employed as furnace-hearths. On Decker's creek a small seam of coal, three or four inches thick, has been found in this rock.

*Coals*, No 18 and 20, seem to represent the Tionesta group of Pennsylvania. As exposed on Decker's creek, they are of no importance. No. 18 gives the following: coal 8 in.; shale 4 in.; coal  $1\frac{1}{2}$  in.; shale 2 in.; coal 1 in.; shale 1 in.; coal 4 in. A very hard, refractory sandstone lies between the coals, and contains numerous indistinct vegetable impressions. No. 20 is one foot thick, and of good quality. On Decker's creek these may be seen near the bridge, below Hagidore's mill. On Booth's creek only one of the seams was seen. Its thickness is 18 inches. At Nuzum's mill it is as irregular as the Briar Hill coal of Ohio. Along the railroad cutting, for some distance, it shows itself about three feet thick, but as it approaches the station, the underlying fire-clay increases in thickness, while the coal diminishes, until at length the coal entirely disappears. At this locality the bed has been worked to a slight extent, and has yielded a coal of excellent quality. The fireclay seems not to be inferior to that of Dover, Ohio, which it resembles greatly.

The *Iron Ores* of this group are of some importance.—In No. 6, the ore is a rich hematite, in nodules which frequently contain sharp vegetable impressions. This ore was extensively used at the old furnace on Decker's creek, as well as at Clinton Furnace.—In No. 21, there are two bands, quite persistent. The ore is quite impure, but works well when mixed with better ore. At Nuzum's mill, a very extensive deposit rests on this shale. The ore is very good, but is in immediate connection with the fire-clay, upon which it sometimes encroaches. The nodules are frequently encrusted with the clay, which may, perhaps, prove a hindrance to successful working. These ores have been thoroughly discussed by Prof. W. B. Rogers in his report on property connected with the Pridevale Iron Works, on Cheat River.

#### THE GREAT CONGLOMERATE.

This formation varies considerably in character, some of the strata being very coarse, with quartz pebbles, three-quarters of an inch thick, while others are fine-grained, and resemble quartz, etc. It disappears on Cheat River, near Ice's Ferry, on Decker's creek, near Hagidore's mill, and on the Monongahela, near Nuzum's mill. In the gaps made by these streams the channels are obstructed by huge masses of the rock, some of them as large as an ordinary log house, and weighing not less than one thousand tons. At no point is it well enough disclosed to afford satisfactory measurement or a knowledge of the succession of strata, so that our information is derived chiefly from borings.

A section thus obtained on Decker's creek, is as follows :

	FT. IN.		FT. IN.
1. Hard sandstone, with seams of iron ore,	22 4	9. Conglomerate, white, with quartz pebbles,	13 0
2. Shales,	2 8	10. Shales, red and blue,	10 10
3. Sandstone, with carbonaceous matter,	12 8	11. Sandstone, blue, fine,	23 6
4. Shales,	1 8	12. Sandstone, white, fine,	25 6
5. Sandstone, white,	9 0	13. Shales, dark with iron,	6 0
6. Sandstone, black,	18 0	14. Sandstone, blue, fine, very hard,	18 0
7. Sandstone, gray, coarse,	14 0	15. Sandstone, gray, very hard,	15 0
8. Shales, black,	16 6		
			<hr/> 208 08

The record of the boring beyond this point is lost.

Another boring was made west of the Monongahela, four miles below Morgantown. The record was not carefully kept, so that it is impossible to determine the thickness of individual strata. Yet the section is of interest as showing a marked change in constitution within a few miles.

It is as follows :

1. Sandstone, white, very hard,	8. Sandstone, white, coarse,
2. Sandstone, blue,	9. Sandstone, black, very coarse,
3. Sandstone, white,	10. Sandstone, white, very hard,
4. Sandstone, blue, softer,	11. Sandstone, white, coarse,
5. Sandstone, white, fine,	12. Sandstone, white,
6. Sandstone, white, coarse,	13. Sandstone, blue, fine and hard,
depth 218 feet,	14. Sandstone, white,
7. Sandstone, blue, very hard,	15. Sandstone, dark, very coarse.

The shales thus appear to be local.

Thin seams of ore occur at various points; but they are unavailable, as the surrounding rock is so hard that mining would be unprofitable. The thickness of the formation does not vary much from three hundred and fifty feet.

#### LOWER CARBONIFEROUS.

This period is represented by the Umbral of Rogers, which here shows a division of shales, limestone and sandstone.

The *Shales* are not well defined at any point known to me, on the south side of Cheat river, though, as the land is cleared, and the mountain localities become accessible, they will doubtless be found as readily on this as on that side of the river.

The *Limestone*, as ascertained by borings, is one hundred and seven feet thick, and is well exposed in the gaps of Cheat river and Decker's creek. At the limekiln, on the latter stream, ten miles from Morgantown, where both the top and bottom of the rock are concealed, the following section was obtained :

- |  |       |   |        |
|--|-------|---|--------|
| 1. Concealed,                              |       | 6. Limestone, dark, impure, upper layers  |        |
| 2. Limestone, weathering, yellowish white, |       | badly shattered at outcrop; lower         |        |
| flaggy, with fossils,                      | 8 ft. | layers more compact, but breaking         |        |
| 3. Concealed,                              | 12 "  | readily after exposure, fossils very      |        |
| 3. Limestone, dove-colored, compact, non-  |       | numerous,                                 | 10 ft. |
| fossiliferous,                             | 14 "  | 7. Shale, calcareous, lead-colored,       | 2½ "   |
| 4. Limestone, dull, dark gray, weathering  |       | 8. Limestone, weathering and plastic,     | 1½ "   |
| light gray, and breaking readily af-       |       | 9. Shales, very calcareous, brown and     |        |
| ter exposure—with numerous fossils,        | 6 "   | weathering into mud,                      | 2½ "   |
| 5. Limestone, very coarse, gray, compact,  |       | 10. Limestone, gray, compact, non-fossil- |        |
| fossils numerous, and indistinct,          | 6 "   | iferous. Exposed,                         | 8 "    |

On Cheat river two miles above Ice's Ferry, about twenty feet of the rock equivalent to No. 1 of this section may be seen.

A list of the fossils obtained from the upper strata on Cheat river was made out by Meek. The following species are determined; *Monticulipora*, n. s.; *Hemipronites crassus*; *Productus fasciculatus*; *Productus pileiformis*; *Athyris subquadrata*; *Spirifer Keokuk* var.?; *Pinna Missouriensis*?; *Aviculopecten occidentalis*; *Allorisma clavata*; *Bellerophon crassus*?; *Straparollus planidorsatus*; *Phillipsia Stevensoni*; besides undermined species of *Allorisma*, *Macrocheilus*, *Naticopsis*, *Bellerophon*, *Pleurotomaria* and *Cyrtoceras*. This grouping of species shows unmistakably that the upper portion of this limestone belongs to the horizon of the Chester group. It is interesting to observe how closely it is related to the coal measures of the West. *Hemipronites crassus* is a characteristic form in the Western coal measures, and never before was found below them. The *Spirifer* hesitatingly identified with *S. Keokuk* var. (= ? *S. Leidyi*) is very closely allied to *S. optimus* of the coal measures. An imperfect specimen of *Bellerophon* obtained here cannot easily be distinguished from *B. carbonarius*, while the *Cyrtoceras* is closely related to *C. curtum* of the Illinois coal measures.

As these fossils were obtained from the upper strata of the limestone, I did not deem it unreasonable to suppose that, lower down, the equivalents of the St. Louis and Keokuk group might be found; and especially because in Randolph County, West Virginia, specimens of *Lithostrotion* occur quite plentifully. Recent examinations have not justified these expectations; for although in No. 6 of the section, the grouping of species is different from the above, yet the whole has such a Chester aspect that I am compelled to regard the limestone throughout as of Chester age. Further study, however, is desirable, as one or two forms closely related to St. Louis species, occur in No. 6.

The Sandstone is not well exposed, and no satisfactory information respecting it can be given. It varies in color from light gray to brownish, and is moderately fine in texture. The thickness cannot be determined.